Consultative Group on International Agricultural Research
CGIAR
Study Paper Number 4

Costa Rica and the CGIAR Centers

A Study of Their Collaboration in Agricultural Research

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At its annual meeting in November 1983 the Consultative Group on International Agricultural Research (CGIAR) commissioned a wide-ranging impact study of the results of the activities of the international agricultural research oganizations under its sponsorship. An Advisory Committee was appointed to oversee the study and to present the principal findings at the annual meeetings of the CGIAR in October 1985. The impact study director was given responsibility for preparing the main report and commissioning a series of papers on particular research issues and on the work of the centers in selected countries. This paper is one of that series.

The judgments expressed herein are those of the author(s). They do not necessarily reflect the views of the World Bank, of affiliated organizations, including the CGIAR Secretariat, of the international agricultural research centers supported by the CGIAR, of the donors to the CGIAR, or of any individual acting on their behalf. Staff of many national and international organizations provided valued information, but neither they nor their institutions are responsible for the views expressed in this paper. Neither are the views necessarily consistent with those expressed in the main and summary reports, and they should not be attributed to the Advisory Committee or the study director.

This paper has been prepared and published informally in order to share the information with the least possible delay.

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SUMMARY

In Costa Rica, the National Agricultural Research System (NARS) is formed principally by the Dirección de Investigaciones Agrícolas of the Ministry of Agriculture (MAG), the University of Costa Rica through its Faubio Baudrit Experimental Station, and the Technical Department of the Consejo Nacional de Producción (CNP). These institutions are linked mainly through cooperative agreements and through the Minister of Agriculture, who is on the board of directors of the CNP (by law) and on the faculty at the University. Other institutions of the sector such as the rural credit departments of the National Banking System and the Institute for Agricultural Development are not formally linked.

People in the higher levels of the government are not conscious of the importance of agricultural research, except for rice, which explains the small research budget. In 1982, only 0.26 percent of the national budget went to agricultural research and 0.34 to agricultural extension.

The most prevalent links with the international agricultural research centers (IARCs) are periodic visits by scientists and the international testing nurseries. CIAT's beans program has a regional representative, located in Costa Rica, who is in constant interaction with the local beans group.

The division of research efforts between the Costa Rican NARS and the IARCs varies from program to program, but in general the IARCs do the basic research and the NARS does field testing, evaluations and further selection of genetic materials. Some programs are now doing crosses in Costa Rica.

The NARS scientists' general perceptions of the contributions made by IARCs is very good. The flow of information was classified as good by all programs, except the

pasture program, which would like more information, more frequently. The genetic material provided by the IARCs has been the basis for the national commodity programs; this contribution was rated as excellent. The contributions of the IARCs in terms of enhancing human capital has been essential to the existence of the commodity programs. There is general feeling that training in seed production at the field level is highly necessary and urgent. Most of the research methods used by the NARS were learned during training at the IARCs or from IARC's scientists during their technical assistance visits. Those methodologies have had an important role in the functioning of the programs and are acknowledged by the NARS scientists. Contributions made by the IARCs in the form of equipment, materials, etc. have been very important to the programs and have sometimes rescued the product of years of research.

Very little documentation exists on the spread and impact of innovations. Most of the information on this issue consists of subjective estimates by the scientists. They estimated that 35-40, 10-15 and 100 percent of the crop area is planted to improved varieties of beans, corn and rice, respectively. All of the improved varieties came out of NARS-IARCs collaboration. The CNP said that sales of improved beans seed was up 400 percent in 1984 with respect to 1983.

The rice program will soon release the varieties CR-1821 and CR-1549 which are resistant to pyricularia and have the potential of yielding at the farm level 11 and 9 tons/Ha, respectively. The beans program will release the ICTA/CIAT material D-145, under the name of Huasteco, which is expected to have a large production impact.

Factors that reduce the impact of the collaboration between the NARS and the IARCs are: the total separation of research and extension, the need for better organization and coordination of the national commodity programs, the NARS need for better

equipment and more personnel, the lack of validation of new technologies, the limited dissemination of research results and the need for better coordination between the MAG and the CNP, in terms of what varieties to promote, multiply and sell.

Basic grains pricing policies of the CNP have played an important role in the development and demand for new technology. Those policies have, for example, favored rice producers during the period 1950-1971 and heavily taxed producers of beans. Inadequate agricultural credit (or its misallocation) has been important in this respect, with more credit going to export crops. Other aspects of the institutional and/or economic environment which seem to have influenced the demand for technology during the later years are the reduced storage capacity for some crops, the P.L. 480 program (providing cheap rice) and the high direct and indirect taxes imposed on the production of grains, especially rice.

Non-CGIAR institutions have contributed to the strengthening of the system through financial support, graduate training, equipment and technical assistance. The current Inter-American Development Bank (IDB) "Programa de Incremento de la Productividad Agrícola" (PIPA) is solving a great deal of the system's financial and equipment problems, making it more able to take advantage of the IARCs collaboration. The University of Mississippi has been instrumental in the development of seed technology in Costa Rica, and USAID has financed certain agencies and programs and provided graduate training.

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Measurements and Currency

Currency: The Colon
Exchange Rate: (July 1984) 1 dollar = 48.75 colones

Measurements

1 Hectare (Ha) = 10,000 sq. meters = 2.47 acres
1 Manzana (Mz) = 7,449 sq. meters = 1.84 acres
1 Ton = 1,000 kilograms = 2,204.6 lbs.
1 Quintal (qq) = 100 kilograms = 220.46 lbs.

Abbreviations and Acronyms

BCCR = Banco Central de Costa Rica (Central Bank of Costa Rica)
CATIE = Centro Agronómico Tropical de Investigaciones y Enseñanza (Tropical Agronomic Center for Research and Teaching)
CGIAR = Consultative Group on International Agricultural Research
CIAT = Centro Internacional de Agricultural Tropical (International Tropical Agriculture Center)
CIGRAS= Centro de Investigación en Granos y Semillas (Center for Research in Grain and Seeds)
CIMMYT= Centro Internacional de Mejoramiento de Maíz y Trigo (International Maize and Wheat Improvement Center)
CIP = Centro Internacional de la Papa (International Potato Center)
CNGB = Cámara Nacional de Granos Básicos (National Basic Grains Chamber)
CNP = Consejo Nacional de Producción (National Production Council)

CONICIT= Consejo Nacional de Investigaciones Científicas y Tecnológicas (National Council for Scientific and Technological Research)

DGEC = Dirección General de Estadísticas y Censos (Division of Statistics and Censuses)

DIA = Dirección de Investigaciones Agrícolas (Division of Agricultural Research)

FAO = Food and Agricultural Organization (of the United Nations)

FERTICA = Fertilizantes de Centro América (Central American Fertilizers)

IARC = International Agricultural Research Center

IBPGR = International Board for Plant Genetic Resources

ICTA = Instituto de Ciencias y Tecnología Agrícola (Guatemalan Agricultural Research Institute)

IDA = Instituto de Desarrollo Agrario (Institute for Agricultural Development)

IDB = Inter-American Development Bank

INTSOY = International Soybean Project

MAG = Ministerio de Agricultura y Ganadería (Ministry of Agriculture and Livestock)

MEIC = Ministerio de Economía, Industrias y Comercio (Ministry of Economics, Industry and Commerce)

MIDEPLAN= Ministerio de Planificación (Ministry of Planning)

NARS = National Agricultural Research System

ONS = Oficina Nacional de Semillas (National Seeds Office)

PIPA = Programa de Incremento de la Productividad Agrícola (Program for Increasing Agricultural Productivity)

PRECODEPA=Programa Regional Cooperativo de Papa
(Cooperative Regional Potato Program)
SBN = Sistema Bancario Nacional
(National Banking System)
UCR = Universidad de Costa Rica
(University of Costa Rica)

CHAPTER 1. BACKGROUND INFORMATION

1.1 The Country

1.1.1 Natural and Political Setting

Located in a narrow strip between Nicaragua and Panamá, Costa Rica is the second smallest Central American country. Its physical size is 51,022 sq. km. (19,700 sq. mi.), slightly smaller than West Virginia. The terrain is mostly rugged mountains and hills cut by many streams and rivers. Three volcanic mountain ranges run the length of the country, with elevations in the southern Talamanca Range reaching 4,000 meters (13,000 ft.) above sea level. In 1984, 60 percent of the area was forest, 30 percent agricultural (22 percent meadow and pasture, 8 percent cultivated), and 10 percent waste, urban and other.

Politically, the country is divided into seven provinces (San José, Alajuela, Cartago, Heredia, Puntarenas, Guanacaste and Limón) and these into a total of 80 cantons and districts.

The tropical location (8°-11° north of the equator), warm off-shore waters, and especially the elevation differentiate regional climates. The five agro-ecological zones in which the country has been subdivided along with some of their characteristics are listed in Table 1 and are shown in the accompanying map (Fig. 1).

Costa Rica is a democratic republic with a strong system of checks and balances. The elections of 1899 began a trend maintained with only a few lapses, the last one being the 1948 revolution which led to the 1949 constitution. The President is elected for a single four-year term along with two vice presidents, the legislature consists of a 57-delegate

Table 1. Agro-ecological zones of Costa Rica

Region	Characteristics	Provinces	Principal Crops
Dry Pacific	Hot, dry, low flat land. Rain: March-November approx. 2,000 mm.	Guanacaste and Northern Puntarenas	Rice, corn, sorghum, beef, and sugar cane
South Pacific	Hot, humid, high and low lands. Rain: approx. 2,600 mm.	Southern Puntarenas Southwest San José	Rice, beans, corn, tobacco, bananas
Central Plateau	High land. Av. 1,000 mts. Rain: May-Nov approx. 1,000 mm	Cartago most of San José most of Heredia Southern Alajuela	Coffee beans, vegetables, milk
North	Low land. Humid Rain: May-Jan approx. 3,000 mm.	Northern Alajuela Northern Heredia	Bananas, beef, sugar cane, cassava, cocoa
Atlantic	Low, humid tropical Rain: Mar-Jan approx. 4,000 mm	Limón	Bananas, plantains, cocoa, cassava, corn

Source: CNP (1976) and author's own knowledge.

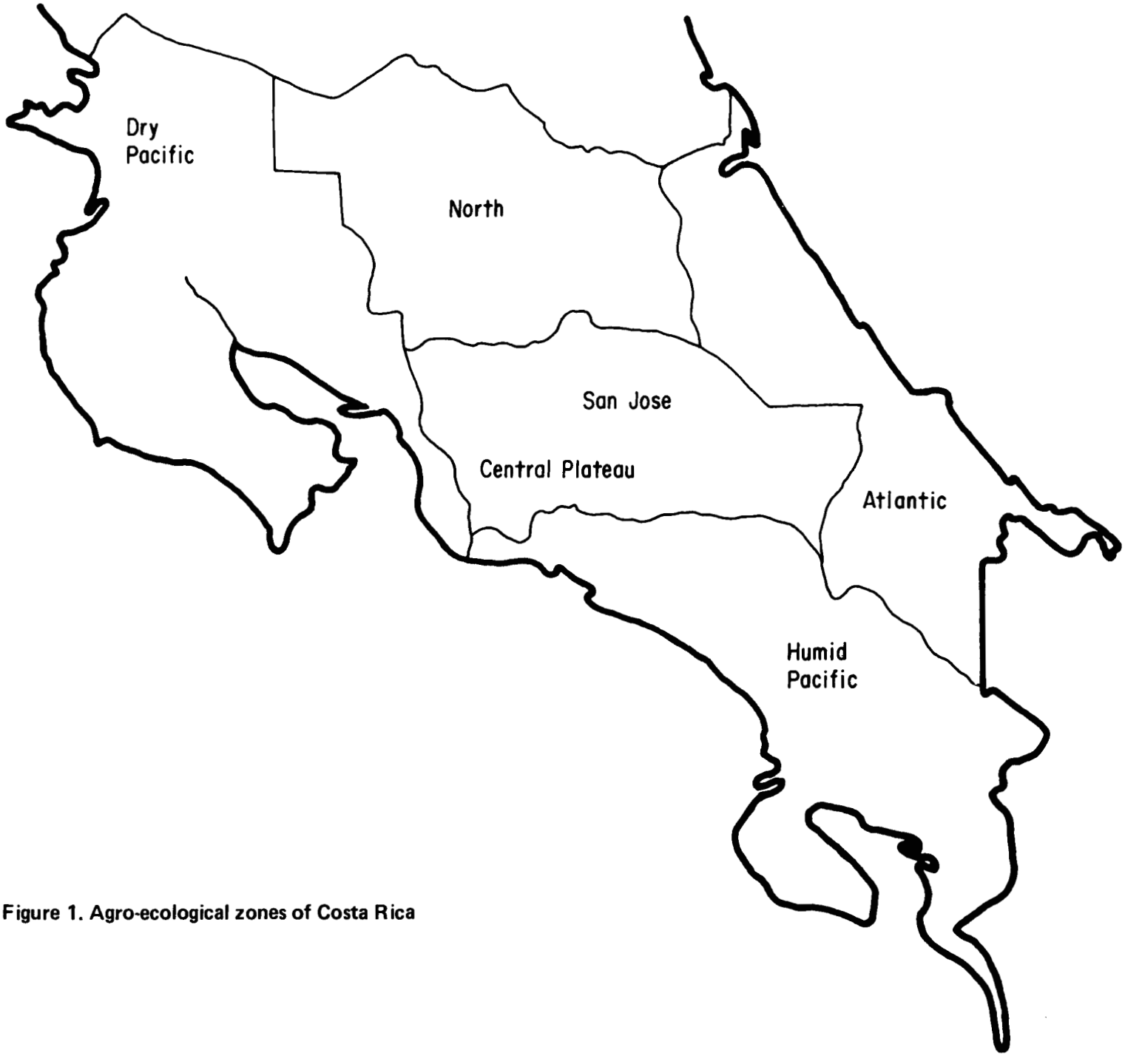


Figure 1. Agro-ecological zones of Costa Rica

unicameral Legislative Assembly elected at four-year intervals, and the judiciary is headed by a Supreme Court of Justice, elected by the Legislative Assembly at eight-year intervals. The military was abolished by the 1949 constitution.

Spanish is the official language, but a Jamaican dialect of English is spoken around Puerto Limón.

The literacy rate is 93 percent (1984).

1.1.2 Population

The mid-July 1984 population of Costa Rica was estimated to be 2.693 million, with an average growth rate of 2.6 percent and a population density of 57 per sq. km. According to the last census (1973), 60 percent of the population lived in rural areas, and 40 percent lived in the central plateau. Ethnically the population is made up of 96 percent white (including mestizo), 3 percent black and 1 percent Indian.

1.1.3 The Economy

Costa Rica is a middle-income country, with a GDP of $3.3 billion (1983 est. in current prices), and a per capita income of $1,390 (CIA, 1984). In 1981 the real income per capita was estimated to be falling at a rate of 3.6 percent per year (U.S. Department of State, 1984). In the same year agriculture contributed 18 percent of GDP and industry 30 percent. The rest was contributed by the service and other sectors, including the government. There was a 0 percent real growth rate in 1983.

The 1982 labor force was estimated at 891,000 (CIA, 1984), with 40.4 percent in industry and commerce, 32.5 percent in agriculture, 25 percent in government and services, and 2 percent in other activities. Unemployemnt was 12 percent in 1983.

Despite an average inflation rate of 50 percent for the period 1980-1983, the colon was stabilized at $43.25 per dollar, falling from the 1970 rate of $6.63 per dollar. Since 1981, the government has been on a course of disciplined management, in consultation with the International Monetary Fund and the World Bank, to bring expenditures into line with available resources and to reduce internal and external debt.

Trade. Costa Rica exports mainly coffee, bananas, beef, sugar and cacao, and imports manufactured products, machinery, transportation equipment, chemicals, fuels, foodsstuffs and fertilizer. In 1983 its exports were valued at $870 million (C.I.F.). The five agricultural products listed above accounted for 60 percent of the total value of exports. Table 2 shows the value and price index of the principal export crops for the period 1979-1983.

Public Budget. In 1981 the budget of the central government was estimated to be $1.024 billion, which was roughly 20.5 percent of GDP (U.S. Department of State).

1.2 The Agricutural Sector

1.2.1 Structure

The National Production Council (CNP, 1976) pointed out that the agricultural sector can be divided into two subsectors: (1) the modern subsector which exports coffee, bananas, sugar, beef and cocoa and (2) the traditional subsector which produces basic grains (rice, beans, corn), fruits, vegetables, milk products, poultry, eggs, etc. Medium size and large farms produced 70 percent of the value of agricultural output. Eighty-eight percent of the value of the production of large farms and 62 percent of the value of the production of medium size farms was exported, while roughly 70 percent of the value

Table 2. Costa Rica: Price indices of export crops and total value of imports and exports

(in millions of colones)

Year	Total Export	Coffee	Bananas	Sugar	Beef	Imports
1979	8,008	2,703	1,487	146	700	11,971
1980	8,585	2,112	1,724	347	606	13,201
1981	21,940	5,239	5,373	938	1,609	26,301
1982	29,948	8,151	7,849	571	1,826	30,732
1983	35,892	9,454	9,607	981	1,179	35,892

	Wholesale Price Index	Wholesale Price Index	Export Price Index	Export Price Index
1979	112.5	81.9	43.9	94.8
1980	100.0	100.0	100.0	100.0
1981	195.1	302.6	262.5	207.5
1982	334.6	437.4	214.3	322.0
1983	407.1	536.9	373.4	401.6

Source: IMF, 1984.

of the value of the production of small farms was used for domestic consumption.

In basic grains, rice has evolved from the traditional to the modern sector, with farms of 100 Ha or more producing 67 percent of the rice (rice yields were found increasing with farm size), whereas farms this large produced only 20 percent of the corn and 12 percent of the beans. Small farms of 5 Ha or less (60,000 of them) produced 68 percent of the corn, 85 percent of the beans and 18 percent of the rice. the 1973 agricultural census (next is the 1984, not yet available) reported the following size distribution of farms.

1.2.2 Infrastructure and Institutional Support

(a) Roads

Except for the northern region, which has always had road communication problems, the road system of Costa Rica is adequate to permit a good flow of agricultural products to markets. The system was improved very much in 1972 with the opening of a new highway to Limón, and again later with the inauguration of the road linking the north to the rest of the country. The completion of the highway between Guápiles (Atlantic) and San José (the capital) is expected to have a great impact on the agriculture of the northern and Atlantic regions.

(b) Government Agencies

The agricultural sector is supported by the following government agencies:

1. The Ministry of Agriculture (MAG) is responsible for agriculturual research and extension, including genetic seed production.

Table 3. Costa Rica: Distribution of farms by size in 1973

Size	Number of Farms	Hectares
Total Farm Land	76,998	3,122,456.1
Under 1 Ha	14,413	6,185.8
1 to 5 Ha	20,830	52,820.4
5 to 10 Ha	9,095	64,846.3
10 to 50 Ha	21,213	510,314.4
50 to 100 Ha	5,801	396,733.1
100 to 500 Ha	4,851	968,931.3
500 to 2500 Ha	715	659,504.0
Over 2500 Ha	80	463,754.2

The 1973 census also reported the following land tenure regime.

Tenure		Percent
Producer owned		85.41
Leased:	[rent	1.81
	[sharecropping	0.44
	[no charge	2.14
	[other	0.30
Mixed:	[onwed and leased	4.31
	[owned and sharecropping	1.01
	[other mixed forms	4.37
Other simple forms		0.21
		100.0

2. The National Production Council (CNP) is responsible for the marketing of agricultural products, including price setting, and the production and sale of certified seed.
3. The Ministry of Finance (MEIC) is charged with setting wholesale and retail prices of basic grains together with the CNP, and is also responsible for setting the prices of seed together with the National Seed Bureau (ONS).
4. The rural boards of the National Banking System (SBN) are charged with providing agricultural credit to farmers and seed producers.
5. The Grains and Seed Research Center (CIGRAS) of the (UCR) is the official seed laboratory.
6. The National Seed Bureau (ONS), although assigned to the Ministry of Agriculture, is judicially and operationally independent. This is the only office that can certify seed in Costa Rica. It controls the quality of all domestically produced and imported seed. The ONS is a member of the "varietal committee," the only body that can approve and name varieties. (CIAT's regional representative is a member of the beans varietal committee.)
7. The National Council on Scientific and Technological Research (CONICT) was created in 1972 to promote the development of science and technology through systematic research or creative acts and to aid the government of Costa Rica in the definition of scientific and technological policies. In 1982, through a project with the Canadian IDRC, it created the "Comisión Nacional de Investigación Agropecuaria (CONIAGRO)", formed by MAG, UCR, CNP, CONICIT and MIDEPLAN (Ministry of Planning), to coordinate the actions of all the institutions in the agricultural sector. CONIAGRO was disolved in 1982.

8. The Agrarian Development Institute's principal responsibility is to make land available to landless farmers, which it does mainly through settlements. It also provides technical assistance and other services to the farmers on these settlements.
9. The University of Costa Rica does agricultural research and some extension at its "Fabio Baudrit" experimental station.
10. Fertica, a fertilizer company, was recently acquired by the government. This company has adequately supplied the farmers with fertilizers for decades.

(c) Private Organizations

1. Seed Producers. Private seed producers did not play an important role until the late 1970s. Today they provide a very important service to the sector. There are essentially four seed producers (multipliers) in Costa Rica who actively participate in the production and sale of rice seed. These are:

   A. The Consejo Nacional de Produccion (CNP; official).
   B. Arrocera La Hilda Ltd.
   C. Central Agrícola de Cartago S.A.
   D. Semillas del Tempisque, S.A.

   In the case of maize, Central Agrícola de Cartago produces Pioneer hybrid seed in addition to local NARS varieties.
2. Farmers Organization (National Chamber of Basic Grains): This organization of grain producers, formed in 1979, was in 1984 conducting agricultural research and providing technical assistance and other services to both members and non-members.

3. Rice Miller's Organization: Rice millers play a very important role in the marketing of rice and the processing of rice for seed.

1.2.3 Pricing

In Costa Rica most agricultural prices are set and controlled in one form or another. The farm price for basic grains is set by the National Production Council (CNP) in advance of the cropping season, while the wholesale and retail prices are set by the CNP in conjunction with the Ministry of Finance. Tobacco farm prices are set by a board called La Junta del Tabaco, of which the CNP is a member. Coffee prices are administered by the "Oficina del Cafe." Most other retail prices are set by the Ministry of Finance, which enforces these prices through police control. The CNP enforces the prices of basic grains by acting as a farm gate purchaser, a wholesaler and a retailer, and by holding a monopoly on the foreign trade of grains.

1.2.4 Past and Present Performance

Up until 1950, the agricultural sector was the most important sector in terms of contributions to GNP. But, according to Corrales (1981), policies followed during and after the 1950s caused a secular decline in agricultural productivity. In 1950, the agricultural sector contributed 40.9 percent of GNP, which declined to about 17.8 percent in 1980 (OFIPLAN, 1982). In 1981 its contribution was still 18 percent.

Between 1953 and 1962 roughly 95 percent of the value of exports was agricultural, represented mainly by coffee, bananas and cocoa; by 1968 beef and sugar were also important export crops. The industrial sector produced 13.4 percent of the gross

national product in 1950 and 20.4 percent in 1975 (OFIPLAN, 1982). Between 1957 and 1980 the industrial sector grew at an annual rate of 7.8 percent (in terms of contribution to GNP), compared to a growth rate of 4.3 percent in the agricultural sector.

(a) Basic Grains

The performance of the basic grains subsector is highlighted by the data in Tables 4-7. Table 4 shows that rice yields more than tripled between 1966 and 1981. Table 5 shows the stagnation of beans yields. Table 6 shows some improvement in corn yields and a steady decline in the area planted to corn, and Table 7 shows that sorghum yields were relatively stable, with acreage steadily increasing.

(b) Export Crops

The performance of the export crop subsector between 1960 and 1984 was superior to that of the basic grains subsector. Coffee and banana were the two most important export crops. Coffee production went from 64 thousand tons on 1960 to 122 thousand tons in 1981; and coffee exports represented 9 percent of GDP in both years. The value of banana exports went from 4 percent of GDP in 1960 to 9 percent in 1981.

The value of the four major agricultural exports--coffee, banana, beef and sugar-went from 16 percent of GDP in 1960 to 38 percent in 1981, whereas the total value of basic grains (rice, corn, beans, sorghum) declined from 3.4 percent of GDP in 1960 to 2.5 percent in 1980. In 1979 coffee accounted for 34 percent of the total value of exports and bananas 18 percent; by 1983 coffee share dropped to 26 percent while banana increased to 27 percent. Together the four exports crops accounted for 63 percent of the value of total exports in 1979 and 59 percent in 1983.

Table 4. Costa Rica: Area, production and yields of rice, 1965/66-1980/81

Crop Year[a]	Production (000 m tons)	Area (000 has)	Yields (T/Ha)
1965-66	30.1	41.2	0.73
1966-67	30.8	44.7	0.69
1967-68	39.4	57.2	0.69
1968-69	67.1	64.3	1.04
1969-70	63.6	63.5	1.00
1970-71	71.2	62.7	1.14
1971-72	92.7	64.2	1.44
1972-73	97.4	86.1	1.13
1973-74	116.8	71.5	1.63
1974-75	126.7	79.5	1.59
1975-76	195.6	87.1	2.25
1976-77	149.7	80.1	1.87
1977-78	168.6	71.0	2.37
1978-79	196.3	73.7	2.66
1979-80[b]	236.8	81.2	2.92
1980-81[b]	243.3	84.2	2.89
1981-82[c]	180.0	70.0	2.57

NOTES:

a August-July
b Estimates
c FAO estimates
n.d. Not available

Source: Consejo Nacional de Producción.

Table 5. Costa Rica: Production, planted area, yields and imports of beans 1973/4-1983/4

Growing Season	Production (000 M Tons)	Area (000 has)	Yields (T/ha)	Imports[1] (000 M/T)
73-74	4.7	7.2	.664	33.10
74-75	13.9	35.5	.391	4.70
75-76	16.2	35.5	.456	.12
76-77	14.0	27.5	.510	.18
77-78	14.0	24.1	.579	.30
78-79	11.3	21.9	.516	5.20
79-80	11.5	24.8	.462	10.30
80-81	12.2	23.6	.519	10.40
81-82	16.3	35.5	.459	15.00
82-83	14.3	39.1	.370	4.00
83-84	19.6	38.6	.520	1.10

[1] until 1979, data from DGEC (official statistics bureau). 1979-83, data Depto. Proveeduria CNP.

Source: Consejo Nacional de Producción.

Table 6. Costa Rica: Production, planted area, and yields of maize 1965/6-1981/2

Growing[1] Season	Production (000 M Tons)	Area (000 Has)	Yield (T/Ha)
1965-66	62.2	54.6	1.14
1966-67	67.6	57.8	1.17
1967-68	71.4	61.0	1.17
1968-69	62.5	52.3	1.19
1969-70	61.3	50.6	1.21
1970-71	61.5	43.4	1.41
1971-72	64.6	44.0	1.47
1972-73	64.5	42.3	1.52
1974-75	87.0	60.5	1.44
1975-76	42.0	41.0	1.02
1976-77	91.7	64.7	1.42
1977-78	88.9	52.9	1.68
1978-79	77.5	43.7	1.77
1979-80	75.2	44.0	1.71
1980-81	65.1	38.8	1.68
1981-82	83.7	45.4	1.84

[1] August-July

Source: Consejo Nacional de Producción.

Table 7. Costa Rica: Production, planted area, and yields of sorghum 1965/6-1982/3

Growing Season[a]	Production (000 M Tons)	Area (000 Has)	Yield (T/Ha)
1965-66	13.0	n.d.	-
1966-67	9.8	n.d.	-
1967-68	9.0	n.d.	-
1968-69	8.0	n.d.	-
1969-70	8.3	n.d.	-
1970-71	7.2	2.7	2.63
1971-72	11.8	4.5	2.63
1972-73	13.8	7.0	1.97
1973-74	16.4	n.d.	-
1974-75	14.1	7.2	1.94
1975-76	19.7	10.7	1.84
1976-77	30.8	18.8	1.63
1977-78	40.9	14.9	1.64
1978-79	52.5	23.8	2.20
1979-80	33.6	18.1	1.85
1980-81	39.7	20.7	1.91
1981-82[b]	45.0	22.0	2.04
1982-83[b]	40.0	20.0	2.00

[a] August-July

[b] FAO reports

Source: Consejo Nacional de Producción.

1.2.5 Policy Issues

(a) Basic Grains Pricing Policies

The pricing policies of the CNP were studied extensively by Stewart (1984), who found that the difference between the prices set and the world prices (border prices) varied from crop to crop and from year to year. In the rice market, for instance, there were two distinct periods. In the first 1950-1971, prices were distorted to favor producers and tax consumers. In the second, 1972-1980, the reverse occurred. In the beans market throughout the 31-year period 1950-80, the prices were set well below world prices, discouraging production

and encouraging consumtpion and imports. In the corn market the prices set generally favored producers, stimulated production and taxed consumers. The domestic and world prices for basic grains and the nominal rate of protection are found Tables 1-4 of Appendix A.

(b) Agricultural Credit

Larson and Vogel (1980) found that the credit policies of the government worked against agriculture. The policies consisted of subsidizing the interest rate to agriculture in general but rationing the credit to the traditional sector, except for rice. Most of the agricultural credit went to coffee, sugar, beef, bananas, and dairy products.

CHAPTER 2. THE NATIONAL AGRICULTURAL RESEARCH SYSTEM

2.1 Overview

In Costa Rica the National Agricultural Research System is characterized by a number of public and semi-public institutions doing the same kinds of research, with little coordination between them. By definition, the Ministry of Agriculture should be the leading research institution, but other institutions or agencies have exercised leadership in some crops or production aspects.

The structure of the Ministry of Agriculture has been adequate for relevant agricultural research. It currently has three experimental stations and one substation distributed over three important regions of the country: Atlantic, Central Plateau and North Pacific. Besides these stations, there is a Regional Agricultural Center (CAR) in each of the seven provinces, and many cantonal agricultural centers (CAC) in each province. The main function of the CARs and CACs is to coordinate and provide technical assistance to farmers in the different areas, but it could be used to coordinate research and extension efforts on a regional basis. The current (1985) union of the directorate of research and extension was conceived partly to foster this coordination.

Because of the emphasis placed by the government on the production of basic foodstuffs, the Ministry of Agriculture's mandate has been to develop and transfer technology to producers of those crops. The development of technology for export crops has been done mainly by private organizations. However, the Ministry has entered into cooperative agreements with the sugar producers' organization, Liga de la Caña, and the coffee producers' organization, Oficina del Café, whereby these organizations provide part of the resources needed to undertake specific research. Banana research has been done by the

multinationals or by the National Banana Producers Association (ASBANA). ASBANA has also done research on non-traditional crops such as black pepper, sweet potato, ginger and dasheen. The four year old organization of basic grains producers, Cámara Nacional de Granos Básicos, is currently developing and trasnferring technology for rice, beans, corn and sorghum. Because the producers themselves are members, the transfer to farmers of any technology developed can be done easier and quicker than traditionally, and could have great impact.

The commodity programs of the Ministry of Agriculture and the other institutions, as they are known today, did not come about until the CGIAR centers started operation. The CGIAR centers, through the provision of genetic materials and training, have played an important role in the development of such programs. For example, in Costa Rica, beans research was originally done only by the University of Costa Rica. Later the Ministry and other institutions also started programs, but with no coordination between them. CIAT's program, through its regional representative, has now managed to bring all these together to share responsibilities and form a coordinated and comprehensive national beans research program. The University of Mississippi has played an important role in the development of seed technology in Costa Rica.

2.2 Institutional Structure

In terms of the crops with which the three international centers in Latin America are concerned, the national agricultural research system is formed by sections of four different institutions:

1. The Ministry of Agriculture Directorate of Agricultural Research and Extension (Dirección de Investigación y Extensión Agrícola.)

2. The University of Costa Rica's Fabio Baudrit Experimental Station.

3. The Consejo Nacional de Producción's Agrotechnical Department (Departamento Agrotécnico) and;

4. The Cámara Nacional de Granos Básicos Technical Department (Departamento Técnico).

The largest and leading research unit in Costa Rica is the Directorate of Agricultural Research and Extension (DIA) of the Ministry of Agriculture (MAG). It has no jurisdiction or hierarchy over the other institutions, but works with them mainly under coopeative agreements. The overall structure is depicted in Figure 2.

2.2.1 The Ministry of Agriculture (MAG)

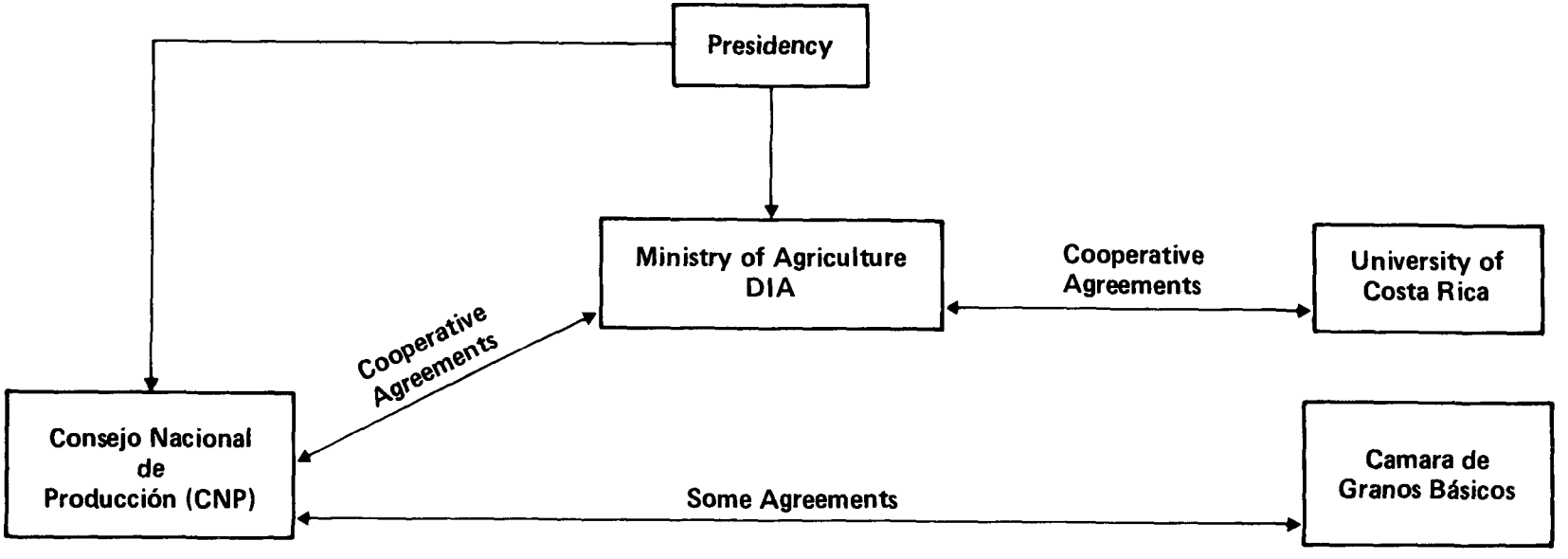
The MAG, as shown in Figure 3, until May, 1985 was divided into several directorates or divisions called direcciones, two of which were the Division of Agricultural Research and the Division of Agricultural Extension. The Division of Agricultural Research was divided into departments, and these were divided into programs. The crop programs are still within the Department of Agronomy and receive support from other departments such as entomology, plant pathology and soils.

Within the agricultural productivity project (IBD, 1982) in May, 1985 the directorates of research and extension were joined under a single directorate called "Dirección de Investigación y Extensión Agrícola."

2.2.2 The National Production Council (CNP)

The CNP's mandate is not only to regulate prices but also

Figure 2. The National Agriculture Research System



*The Minister of Agriculture is on the board of directors of the CNP.

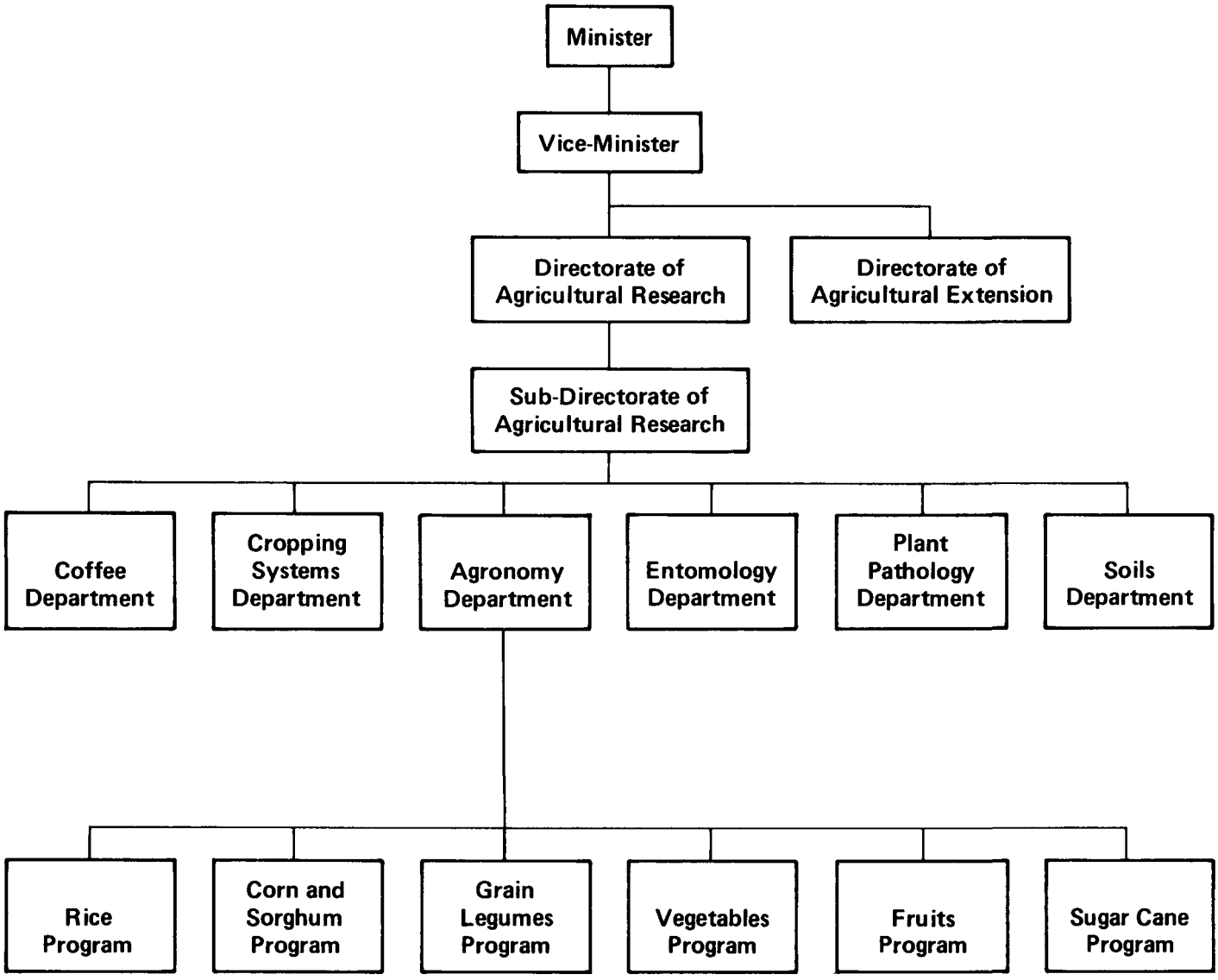


Figure 3. The Ministry of Agriculture

to promote the production of basic foodstuff, using whatever means posible. This is why the CNP has a promotion division called called "División de Fomento de la Producción." The agrotechnical deparment is within this division. This department has rice, corn, beans, sorghum and soybeans programs. These programs are part of the NARS, since they deal with different aspects of the production of these crops, including the production, processing and distribution of improved seed. They also carry out joint research projects with the Ministry of Agriculture and the University of Costa Rica.

2.2.3 The University of Costa Rica

The university is a totally independent institution. It has an agricultural experiment station called Fabio Baudrit, which is located in the Central Plateau. At this station the university has research programs in beans, corn, wheat, fruits and other crops. It works very closely with CIMMYT and CIAT and enters into cooperative agreements with the Ministry of Agriculture and the CNP.

2.2.4 The Cámara Nacional de Granos Básicos

The cámara started out around 1980 as an organization of rice producers, who organized themselves so that they could protect their interests, for example to lobby for better prices. Today the cámara includes producers of all the other grains, large and small. Not feeling well served by the existing NARS, the cañara began its own research and extension programs. It tests genetic materials and chemicals, does fertilizer trials, etc., all on farms of members. In doing this, it has received some collaboration from the Ministry of Agriculture and the CNP, but receives no outside support and may have to discontinue its research program in 1985 for lack of funds.

2.3 Allocation of Resources

The author requested historical budget and staff information many times but, despite assurances, this information was not provided. The information included in this section and the following one came from other written reports. The PIPA project reported the figures contained in Table 8.

Table 8. Costa Rica: The national, MAG, and research and extension budgets for the years 1979-1982 (in thousands of 1982 dollars)

	YEAR			
	1970	1980	1981	1982
Central Government	182,690.3	234,859.8	251,711.9	305,516.6
MAG	9,103.3	7,990.3	9,157.6	10,367.7
Research and Extension	1,381.3	1,379.9	1,834.7	1,923.2

Source: PIPA and Ley de Presupuestos.

The research and extension budget in 1984 was roughly 2 million dollars. Table 9 shows the percentages of the national and MAG's budget devoted to research and extension.

Table 9. Costa Rica: Percentages of national and MAG's budget devoted to research and extension (1979-1982)

	YEAR			
Detail	1979	1980	1981	1982
MAG's percentage of national budget	5.0	3.4	3.6	3.4

Table 9 (continued)

Research and Extension percentage of MAG's budget	15.2	17.3	20.2	18.5
Research and extension percentage of national budget	0.8	0.6	0.7	0.6
Resarch percentage of national budget	0.32	0.28	0.29	0.26
Extension percentage of national budget	0.48	0.32	0.41	0.34

Source: PIPA and Ley de Presupuestos.

Table 10 shows the breakdown of the MAG and research and Extension budget according to source of funds.

Table 10. Costa Rica: Percentages of MAG and research and extension resources according to sources, 1979-1982

	YEAR			
	1979	1980	1981	1982
MAG Resources	81.3	88.7	83.2	57.5
National sources				
Funds from Foreign sources	18.7	11.3	16.8	42.5
Research & Extension Resources				
National sources	78.7	100.0	100.0	91.9
Funds from Foreign sources	21.3	-	-	8.1

Source: PIPA

According to Nestel and Trigo (1984), Costa Rica devoted 0.24 percent of its agricultural gross domestic product to agricultural research in 1979. Tables 11 and 12 show the breakdown of Costa Rica's research budget by divisions and by crops for the years 1979-1981. This was obtained from the 1981 ISNAR study. The UCR's agricultural research budget was reported to be roughtly 12 million colones per year.

The Agricultural Extension budget and its breakdown for the years 1979-1981 is shown in Table 13.

Table 11. Costa Rica: MAG's research budget by divisions for years 1979-1981 (in thousands of colones)

Divisions	YEAR 1979	1980	1981
Agricultural Research	15,350	19,841	24,365
Animal Research	1,708	3,134	3,700
Animal Health	1,153	1,448	674
Forestry	1,006	724	936
Fishing and Wildlife	558	446	719
Other Services	-	675	285

Source: ISNAR, 1981.

2.4 Staff

Table 14 contains a list of the professional staff of the Dirección de Investigación Agrícola (MAG) and its level of academic training for the year 1981.

According to the report prepared by MAG for the Proyecto de Incremento de la Productividad Agrícola (PIPA), in 1982 there were 69 professionals in the Dirección de Investigación Agrícola (DIA), of whom 26 percent worked in the coffee program

Table 12. Costa Rica: MAG's 1981 agricultural research budget, by activity

Crop	Colones
Rice	620,736
Banana and Plantain	145,382
Cocoa and Coconut	261,801
Coffee	1,637,350
Sugar Cane	1,657,000
Fruticulture	665,248
Horticulture	1,009,667
Grain Legumes	790,358
Corn	771.055
Tubers and Roots	522,607
Improved Seed	279,200
Cotton	292,769
Castor Oil Plant	51,340
Jojoba	74,900
Production Systems	516,987
Sorghum	239,296
Pastures	19,643
Food Technology	400,800
Division Administration	473,728
Department of Biometry	395,291
Department of Cartography and Soil Conservation	634,765
Soils Laboratory	453,800
Experiment Station "Los Diamantes"	3,087,230
Experiment Station E.J.N.	2,551,997
Head Agronomy Department	248,400
Head Coffee Department	219,600
Head Entomology Department	218,400
Head Plant Pathology Department	261,600
Head Cropping Systems Department	123,600
Head Soils Department	124,800
Experimental Station F.B.	322,440
Training	170,400
Debt Payments	86,000
Subexecution	256,316
Compensation to Minimum Wage	2,268,657
Professional Careers	450,000
Total Budget (colones)	22,304,163

Source: ISNAR, 1981.

Table 13. Costa Rica: MAG's agricultural extension budget for 1979-1981 (in thousand colones)

Budget	YEAR 1979	%	1980	%	1981	%
Extension	28,756.6	100	29,233.9	100	42,889.0	100
Personnel services	21,884.9	76.0	22,667.0	77.5	31,545.1	73.6
Investment	1,035.5	3.6	-	-	822.6	1.9
Operating expenses	5,865.2	20.4	6,564.9	22.5	10,521.3	24.5

Source: Ley de Presupuesto, years 1979, 1980, 1981.

Table 14. Costa Rica: Human resources in agricultural and other research at the MAG in 1981

Program	Directors	Ingenieros Agrónomos	Biologists	Agrónomos Assistant	Secretaries and Office Personnel
Agricultural Research					
Direction	2	2	2		1
Experimental Statistics		1		2	1
Agronomy Department					
Head		2			2
Rice Research		1		1	
Maize, Sorghum, Vegetable Oils		5		4	
Fertilization Research		3		1	1
Horticultural Research		3		5	
Banana, Plantain, Others		3			
Certified Seed		3		1	
Sugar Cane Research		11	1	3	1
Fruticultural Research		2		2	
Total Agricultural Research	2	36	3	19	6

Table 14 (continued)

Coffee Research		10			1
Cropping Systems and Cotton		2		2	
Plant Pathology Department		10		8	3
Entomology Dept		11	1	3	3
Soils Unit					
Soils Dept		1			
Soils Conservation Dept		4		5	1
Diagnosis of Soils, Plants & Water		2	1		1
Soil Fertility and Plant Nutrition		2		1	
Training Dept		1		1	2
Exp Station E.J.N.		2		2	3
Exp Station "Los Diamantes"		3			10
Animal Health			2		2
Agricultural Engineering	1	5	1	19	17
Animal Science Program		8		5	4
Forestry Program		3		8	1
Fisheries and Wildlife			3		3
Total Other Research	1	64	8	54	51

Source: Ley de Presupuestos, 1981.

(Cooperative Agreement MAG/OFICAFE), 35 percent at headquarters and 39 percent in the fields. One percent had Ph.Ds, 9 percent had M.S. degrees, and the remaining 90 percent were mainly Ingenieros Agrónomos.

Table 15 shows the geographical distribution of the Agricultural Research Directorate personnel in 1982.

In 1984, the experimental station Fabio Baudrit of the University of Costa Rica had 15 researchers at the station, of which 7 had an M.S. degree and 8 were Ingenieros Agrónomos.

Table 15. Costa Rica: Distribution of agricultural research directorate (DIA) personnel in 1982

Location	Professionals	Medium Level Technicians	Administratives	Sub-Total
Headquarters and Labs	24	9	13	46
E.S. Jimenez Nuñez	6	2	2	10
E.S. Los Diamantes	7	-	3	10
E.S. Carlos Durán	3	3	-	6
Substation Tilarán	1	1	-	2
Regionals	10	7	-	17
Agreement MAG/OFICAFE	18	-	1	19
Total	69	22	19	110

2.5 External influences

2.5.1 Non-CGIAR Support

Many agencies have supported the NARS in different ways. Some of the most important contributions have come from the USAID, the World Bank and the Interamerican Development Bank. Table 16 contains a small list of some of the most important projects that are currently in execution or approved.

The following is a list of all the agencies that have supported the NARS, along with their contributions (including those in Table 16).

PRECODEPA (Regional Cooperative Potato Program)

PRECODEPA which became operative in 1978, is a regional

Table 16. Costa Rica: Some projects supporting NARS currently in execution or approved

Agency	Project	Amount $ Mill	Date Approved
World Bank	Ag. Research Projects	18.0	12/77
USAID	Production Systems T-027	5.5	10/78
USAID	Science and Technology W-030	1.2	7/80
USAID	Science and Technology V-031	1.0	7/80
USAID	Science and Technology W-034	9.5	5/81
IBD	Project to Improve Agricultural productivity	38.0	1984

Source: IDB, 1982.

potato program financed by the Swiss Development Corporation. The founding member countries are Costa Rica, Dominican Republic, Guatemala, Honduras, México and Panamá. The International Potato Center (CIP) is also a founding member.

This program was conceived to take advantage of each member country's speciality. The network requires each country to specialize in certain research areas and rely on other national programs for research in other areas. Research results and other technological developments are shared through regional seminars, workshops and production courses. Costa Rica is the current leader in tuber moth and bacterial wilt research.

INIA (National Agricultural Research Institute - Mexico)

Cooperates with Costa Rica's potato program through PRECODEPA. It provides mainly genetic material and technical assistance.

ICTA (Guatemalan Agricultural Research Institute)

Cooperates in the same way as INIA.

Government of Holland

Provided training for a corn scientist.

University of Mississippi

Has supported the system in the area of seed handling,through plant design and regular technical assistance. National scientists believe that the University of Mississippi played an important role in the development of seed technology in Costa Rica.

University of Florida

Has supported MAG's pasture program by providing genetic material and regular technical assistance through visits.

CARE (Cooperative for American Remittances Everywhere)

Starter the soybean program in Costa Rica and still cooperates in the area of seed production.

Chinese Mission

Has supported the production of soybeans and soybean seed by scientists.

GTZ (German Development Corporation)

Has financed seed seminars.

AVRDC (Asian Vegetable Research and Development Center)

Has provided soybeans genetic material for testing.

ISTA (International Seed Testing Association)

Has organized seminars on seed quality.

ATO-CHEMIE (French)

Has provided technical assistance and genetic seed of "Higuerilla" (castor-oil plant).

Brazilian Government

Has done the same as ATO-CHEMIE.

W.K. Kellog Foundation

Has financed training of NARS scientists at CATIE.

World Bank

Financed a project during 1978-83 with 18 million dollars to, among other things, provide seed of basic grains, build rural roads and conduct non-crops research on experimental stations. Through the project BIRF-1410, the bank has provided scholarships to NARS scientists for further studies in U.S., and has also financed the construction of plants and buildings.

ARTES (Regional Association of Seed Technologists of Central America and the Caribbean)

Has imparted regional courses in seed technology, with assistance from CIAT, CIMMYT and the GTZ.

SDC (Swiss Development Corporation)

Currently finances PRECODEPA and CIAT's regional beans program in Central America and the Caribbean.

USAID

USAID has supported the NARS in many ways and with many projects.

1. CIGRAS (grains and research center) was created through an AID loan to the government of Costa Rica.
2. AID has provided scholarships for graduate training in the US (University of Kansas, Mississippi State) and has arranged for professors to visit Costa Rica, mainly for training CIGRAS personnel.
3. Through AID PL 480, there is now a project to study the system of post-harvest handling of grains.

4. AID has arranged for visits of scientists from INTSOY to give technical advice on soybeans and has facilitated the entrance of soybean seed to the country.

FAO/UNDP (United Nations)

This organization supports CIGRAS with seminars and by financing the trips of scientists to courses. It is currently carrying out a project called "Grain Handling within the Farm." It supports the MAG through donations and technical assistance in Forestry. In grains and soils, it has helped with laboratory analyses and monetary support.

IDB (Inter-American Development Bank)

The most important supportive activity of the IDB at

this time is the PIPA project. This consist of a 38 million dollar loan to the agricultural research and extension system for:

a. agricultural research and transfer activities
b. agricultural input
c. seed production.

According to the bank, 38,000 medium and small farmers and 2,000 large farmers will benefit from the project. The overall objective of the project is to increase agricultural productivity in the country through the generation, validation and transfer of technology plus adequate supply of agricultural inputs. The money is being used to strengthen the entities involved in agricultural research, technology transfer and the production and distribution of seed.

The bank is also financing a 20 million dollar irrigation project (Proyecto de Riego de Tempisque), which should provide irrigation for 10,000 Ha of land, and money for development loans through the national banking system.

IICA (Inter-American Institute for Agricultural Cooperation)

In order to explain the support of IICA, I include its general objective as stated in its Medium Term Plan 1983-87. It reads, "The general objective is to support the countries in their design of technological policies; in the selection of priorities and the realization of research that is coherent with the true development problems; in the instrumentation of an institutional system that will assure continuity from the generation of appropriate technology to the promotion of adoption by producers; in the assignment of functional responsibilities to the different institutions that form the technological system and in making sure that

they are organized adequately to perform such functions."

IICA has collaborated in two ways.

1. Providing scientists to help with courses designed for NARS researchers.
2. Data processing.

In terms of its relations with CGIAR centers, IICA has a cooperative agreement with CIAT, whereby CIAT's regional representative is an associate member of IICA, and is currently provided a secretary and an agricultural economist paid by IICA.

IICA thinks it has great potential to support the NARS mainly through in-country training.

CATIE (Tropical Agronomic Center for Research and Teaching)

CATIE is a regional research and teaching institute, financed by member countries in Central America and the Caribbean and by organizations outside the area. It works with cattle, forestry, cocoa, coffee, pejibaye and many other crops. It claims to support NARS in four ways:

1. Training scientists at the M.S. level for NARS.
2. Work with NARS developing methodologies for research and extension and determining priorities.
3. Work in teams at specific locations doing on-farm research, in which limiting factors are identified. One such project is currently under way in the Atlantic region of Costa Rica which includes corn-corn and corn-cassava combinations.
4. Offer courses in coffee and other areas.

IDRC (International Development Research Center, Canada)

Financed the creation of the Comision Nacional de Investigaciones Agropecuarias (CONIAGRO). It also works closely with CATIE on many projects.

2.5.2 CGIAR's Influence

Given that the IARCs support and contribute to the NARS in so many different ways, it is difficult to compare their contributions in dollar amounts to those of the non-CGIAR agencies. There is no doubt, however, that the centers' support has been the most important of all. The specific contributions of the centers and their importance will be discussed in the following chapter, but it is pertinent to mention at this point that the collaboration of the centers has fostered a rapid development of the Costa Rican NARS.

In terms of their mandates, the two most important centers have been CIAT and CIMMYT; CIMMYT through its maize program and CIAT through its rice, beans and seed programs. The contributions of these two centers in the form of equipment, materials and financial resources have been acknowledged as invaluable by the NARS scientists.

The International Board for Plant Genetic Resources (IBPGR) has also assisted Costa Rica through CATIE to collect nationally important plant species in northern Talamanca mountains and in some training.

2.6 Effectiveness and Problems

One important problem with the NARS that was emphasized is the lack of dissemination of research results. Scientists from other institutions complained that the MAG's

research results are usually published in an annual report that few people receive. The results of regional trials are an exception; almost all the scientists from the different institutions share these results. This is another accomplishment of the IARCs in the area. The University of Costa Rica (Fabio Baudrit) also does a good job in putting together bulletins and pamphlets for farmers and other scientists.

Another important problem limiting the NARS effectiveness is the lack of inter-institutional coordination, which prevents the attainment of a well-planned and organized national program. Even within the Ministry some programs (for example, the pastures program) are not well organized.

The total divorce between research and extension, the lack of validation of new technologies, and the lack of promotion of the technologies developed were mentioned by interviewees as other important limitations of the NARS. The NARS also suffers from insufficient and obsolete equipment and insufficient manpower. For example, beans scientists asserted that the beans team was too small to attack the numerous problems in Costa Rica.

CHAPTER 3. IMPACT OF THE INTERNATIONAL AGRICULTURAL RESEARCH CENTERS ON THE COSTA RICAN NATIONAL AGRICULTURAL RESEARCH SYSTEM

3.1 General Issues

The insufficiency of both financial resources and trained professional staff in the NARS has been an important factor limiting the impact of the IARCs on the NARS. The fragmentation of the system, as pointed out earlier, has been another factor limiting this impact. An example of this is the fact that CIMMYT regional scientists must work with the scientists at the University and at the Ministry in what seem to be two different programs. The two institutions might have (and have had) different interests. Apparently the political environment is dampening impact in wheat. It appears that vested interests at high levels of government are favoring the continuation of wheat imports and discouraging wheat research.

Some people, particularly those interviewed at CATIE and IICA, believe that the IARCs used to and still do approach the NARS with a certain amount of arrogance, imposing their own programs on the system without much regard for the national needs. They also believe that the technology so generated is of no use to the country. Most of the scientists within the NARS did not share these feelings, however. Even if it were true, I believe that as the NARS scientists become better trained, there will be less opportunity for this kind of uneven relationship.

Scientists at IICA argue strongly that their mandates is to transfer technology to the NARS, and that in this respect they would like to and should collaborate more closely with the IARCs. They expressed interest in a new

working relationship based on the support they give to the NARS. They are interested in joint efforts in which their actions would be complementary to those of the IARCs, given that they only transfer, rather than generate, technologies.

Scientists at CATIE complain that the IARCs have ignored small regional centers like themselves, especially in the role of technology development and transfer. For example, they think that the two regional sorghum specialists from ICRISAT should have been placed at CATIE and not CIMMYT because of logistics and because CATIE also has a sorghum program. They would also like to see ISNAR intensifying its work in these countries.

The centers' involvement has played an important role in the motivation of the national scientists. Without the centers such motivation would undoubtedly be much lower..

Without the centers, resources that were already scarce would likely have been diverted to more basic research. This would have meant a great setback to the NARS programs and the development of fewer improved technologies.

3.2 Biological Materials

In general, the provision of genetic materials by the IARCs was considered to be very good and to consitute the base of most of the NARS commodity programs. Scientists were asked to rate the activities of the centers in terms of their overall quality. The answers to this question and to others were used by the author to develop a summary of measures of the NARS ratings of the different programs. Table 17 provides a summary of how the different programs of each center were rated by the NARS scientists for their contribution of genetic materials. Some comments follow.

Table 17. Costa Rica: NARS scientists' ratings of the centers' contributions of biological materials

Center	Program	Rating			
		Bad	Fair	Good	Excellent
CIMMYT	Corn			X	
	Wheat			X	
CIMMYT/ ICRISAT	Sorghum		X		
CIAT	Rice			X	
	Beans				X
	Pasture		X		X
CIP	Potato			X	

Note: Programs not included were not rated.

One NARS scientist expressed the desire to see more year-to-year continuity in the lines CIMMYT includes in the testing program. Another scientist believes that CIAT's contribution could improve if it would pay more attention to upland rice, which is what Costa Rica grows.

3.3 Research Methodologies

NARS scientists in general agreed that the research methodologies learned at the centers and those acquired through visits of centers' scientists have been very important to their work. They explained that during formal university training they did not learn such methdos, especially as they relate to specific crops. Three observations were made: First, a scientist in the pastures program expressed that this program needed guidance in terms of research methods. Second, some scientists would like for CIMMYT to be directly involved in technology transfer. Third, it was emphasized that CIAT, through its regional representative, is really responsible for the development

and coordination of a beans research program in Costa Rica.

Scientists in the NARS feel very strongly that the IARCs should place greater emphasis on aspects other than pure plant breeding. They would like to see greater research and exchange in the areas of plant pathology, entomology, soils, etc. They also feel the need for training in field seed production and not just seed management (post-harvest).

3.4 Research Organization

The posting of regional representatives by CIAT's beans program has greatly enhanced the communication and effectiveness of CIAT in the region. In Costa Rica, CIAT is being held responsible for the exsitence of a serious beans program. The regional and national nurseries are highly regarded by national scientists. The head of the rice program thinks that a rice representative is highly needed to coordinate a regional rice program.

PRECODEPA, as described earlier, has been the most successful regional program.

CIMMYT operates on the basis of periodic visits of its scientists to the NARS. This modus operandi, although considered to be working relatively well, has not been as successful as the programs with regional representatives posted in the countries.

3.5 Information and Training

Table 18 provides a summary of the overall rating of the IARCs training programs and the flow of information.

Table 18. Costa Rica: Ratings of the IARCs training programs and flow of information

Center	Program	Rating							
		Flow of Information				Training			
		Bad	Fair	Good	Excellent	Bad	Fair	Good	Excellent
CIMMYT	Corn			X					X
	Wheat								
CIMMYT/ ICRISAT	Sorghum		X					X	
CIAT	Rice			X				X	
	Beans				X				
	Seed				X				X
	Pasture	X							X
CIP/ PRECODEPA	Potato				X				X

Note: Programs not included were not rated.

The following important observations were made:

(a) Regional programs like PRECODEPA and the international and regional nurseries and testing programs enhance the flow of information between the centers and the NARS.

(b) The NARS would like to see some emphasis placed on the training of scientists in the art of seed production at the field level.

(c) More follow-up after training and refresher courses are desired by the scientists. They strongly believe that graduate training is currently necessary.

(d) The head of the NARS rice program believes that, in training, more emphasis should be placed on theory and less on frivolous field exercises.

(e) In-country training, they think, should be done more often.

3.6 Relationship Between IARCs and NARS

The division of efforts consists of the IARCs making the appropriate breeding crosses and sending these to the NARS for evaluation and further selection. The NARS is responsible for all other research activities. The scientists recognized that the national program does not have the capacity or the resources to make crosses or to do other basic research; they consider the IARC's work to be indispensable.

The division of efforts is dynamic, changing as the NARS develops. For example, in 1978 almost all the material CIAT sent to the NARS was F_7 or at the final stage of selection. Today, it sends F_2 and similar material at early stages of selection.

As for commodities outside the IARCs' mandate, the NARS does not seem to do any basic research. It works, with other centers or organizations involved with those crops.

It is generally believed that the country's priorities are being reflected in the activities of the centers. The main criticism is that CIAT devotes so many resources and so much attention to irrigated rice when the region grows upland rice. Rice scientists would like to see CIAT paying more attention to the type of rice grown under the conditions of the region. The training program, they claimed, also emphasizes irrigated rice.

CHAPTER 4. RESEARCH IMPACTS ON AGRICULTURAL PRODUCTION

4.1 Important Innovations

There is very little documentation on the spread and impact of innovations stemming from the collaboration between the IARCs and the NARS. Although there has been some agronomic work and on-farm research, the bulk of the innovations seems to be high yielding varieties with resistance or tolerance to many unfavorable conditions.

Corn: A 1981 study by a team from Iowa State University listed some of the new corn varieties developed in Costa Rica from CIMMYT's materials. The list is given in Table 19.

Table 19. Corn production and development of new varieties for Costa Rica

Total Area in Production (Ha)	No. of Trials of CIMMYT Material from 1977-80		New Material Developed with Material from CIMMYT	
40,000	1977	11	TICO V-1	1974
	1978	14	TICO V-2	1973
	1979	12	TICO V-5	1977
	1980	17		

The varieties "TICO V-1 Mejorado" and "Diamantes 8043" are two of the more recent MAG outputs, which were also developed from genetic materials provided by CIMMYT.

The NARS (UCR) obtained from CIMMYT International Nurseries the Cultivars Diamantes 8043 (white) and Tocumen F-428 (yellow), which have shown good adaptation and yield potential.

Rice: The distribution of rice seed by the CNP, given in Table 20, illustrates the evolution of rice materials used by farmers in Costa Rica.

Table 20. Distribution of rice seed by CNP in Costa Rica, selected years (in tons)

Variety	Origin	1965	1975	1983
DIMA		212	-	-
SML Tapuripa		197	87	-
SML Magali		114	-	-
Blue Bonnet 50	U.S.	86	-	-
Precoz Blanco		21	-	-
Centenario		1	-	-
C.R. 1113	CIAT/MAG	-	3,793	1,112
CICA 4	CIAT	-	355	-
CICA 6	CIAT	-	157	-
Holland 5023		-	42	-
C.R. 201	CIAT/MAG	-	-	163
C.R. 5272	CIAT/MAG	-	-	87
Total		631	4,434	1,362

Note: These are only the sales of the CNP, which has lost most of its market share since 1975 when private producers came into prominence.

Source: CNP, Dept. Agrotécnico, Programa Arroz.

Beans: In Costa Rica, the following varieties have resulted from the collaboration NARS/CIAT.

Variety	Color
Huetar	Red
Chorotega	Red
Brunca	Black
Talamanca	Black

Cassava: The Iowa State University study reports a number of cassava varieties containing genetic material from CIAT that were released in Costa Rica. These are shown in Table 21.

Table 21. Cassava production and development of new varieties in Costa Rica

Production Ha	Test Material From CIAT?	Varieties Released Containing Genetic Material from CIAT	Planned Release of New Varieties
2,000	Yes, seven varieties have been tested at 6 testing sites	M Col 1684 M Mex 59 CMC 84 CMC 40 CMC 76 Ven 168 M Col 22 M Mex 17 M Pan 70 M Col 677 AM Col 655 A	1981 planned releases include: HMC - 1 HMC - 2

Source: ISU, 1981

The current use of materials from the different centers is summed up in Table 22 by the MAG's 1984 plans for foundation seed production.

4.2 Adoption of Innovations

4.2.1 Transmission Mechanism

In Costa Rica, the Agricultural Extension Division (Dirección de Extensión Agrícola) of the Ministry of Agriculture with its regional and cantonal centers was the official mechanism for the transmission of agricultural technologies to farmers. The link, however, between this division and the research division was very weak, undermining the effectiveness of the system. In May, 1985 both divisions were integrated into a single division to foster coordination and the transmission mechanism. Many other institutions are involved in the transmission

Table 22. MAG's 1984 plans for producing foundation seed

Crop	Variety	Production(kg)
Rice		
	CR-1113	28,000
	CR-201	401
	CR5272	20,000
	CR-1707	4,000
	CR-(to be numbered)	8,000
Beans	Porrillo Sintético	1,000
	Talamanca	1,200
	Brunca	1,000
	Husateco	1,000
	Huetar	2,000
	Chorotega	1,000
	Mexico-80	800
Corn	Tico V-1 M	3,600
	Tico V-7	3,600
	Los Diamantes	3,600
	Las Cañas	1,500
	Tico V-6	5,100
Frijol de Costa	Centa 105-N	2,000
Soybeans	SIASTA 194-a	1,400
	Jupiter	1,400

process. These includes the rural credit divisions of the national banking system, the CNP, the Agrarian Development Institute, the University of Costa Rica, the grain producers association and private seed (and other inputs) companies.

4.2.2 Extent of Adoption

(a) Corn. NARS scientists estimated that 10 to 15 percent of the corn acreage was planted in 1984 to the varieties TICO V-1 Mejorado and Diamantes 8043.

(b) Rice. NARS scientists estimated that virtually 100 percent of the rice area is now sown to the varieties developed through the MAG/CIAT collaboration. This was substantiated by a study done by Muchnick (1984). Figure 4, showing the rate of adoption of high yielding rice varieties in Costa Rica, was reported by that study.

(c) Cassava. The tropical root crops scientists at the MAG estimated about 80 percent adoption of a technological package developed for cassava.

(d) Beans. NARS scientists estimated that 35 to 40 percent of the beans acreage is planted to the varieties they have developed in collaboration with CIAT. Sales of improved seed in 1984 were up 400 percent over the previous year. Figure 5 depicts the mix of seed sold during the period 1981-83.

4.3 Production Effects

(a) Rice Area and Yields

By 1979 roughly 100 percent of the rice area was planted to varieties produced by the NARS/CIAT collaboration. This is illustrated in Table 23.

Table 23. Quantities of seed of different varieties planted during the years 1979-1983 (metric tons)

Variety	YEAR 1979	1980	1981	1982	1983
CR1113	4,927	7,002	7,192	8,585	7,930
CR5272	2,009	921	156	324	527
CR201	-	-	-	129	390
CICA 7	905	228	-	-	-

Source: MAG

This planted approximately:

Year	Hectares
1979	75,761
1980	78,756
1981	70,998
1982	87,327
1983	85,491

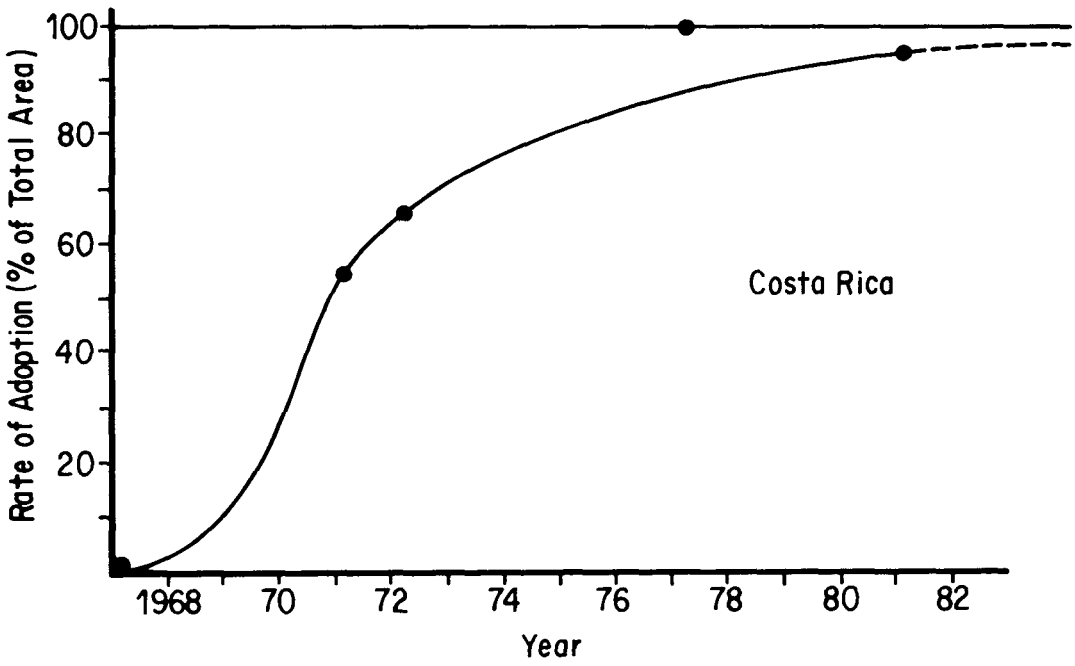


Figure 4. Adoption of high yielding rice varieties in Costa Rica

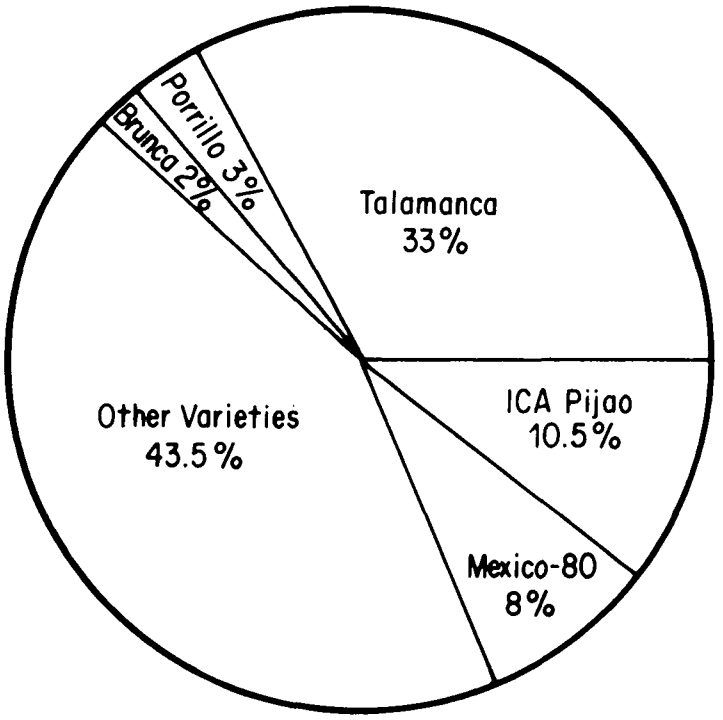


Figure 5. Costa Rica: mix of beans seed sold during the period 1981-83

Table 4 showed that rice yields rose from approximately 0.7 tons/ha in 1965-66 to 2.9 tons/Ha in 1980-81. In 1984-85 yields were 3.2 tons/ha.

(b) Beans Production, Area and Yields

Table 5 showed that beans production rose from roughly 5,000 tons in 1973-74 to roughly 20,000 tons in 1983-84. This increase was due mainly to increases in the area planted which rose from 7213 hectares in 1973-74 to 38,671 in 1983-84. Yields showed no trend, and averaged about 0.5 ton per hectare.

(c) Corn Production, Area and Yields

Table 6 showed that corn production did not increase much between 1965-66 and 1981-82. On the average, acreage fell over the same period. Yields, however, rose from 1.14 tons/Ha to 1.8 tons/Ha over the same period.

(d) Sorghum Production, Area and Yields

Sorghum yields actually fell between 1970 and 1983 according to Table 7, which attributes the production increases to area increases. Area planted went from 13,000 Ha to 45,000 Ha between 1965 and 1982.

It is difficult to tell how much of the yield increases in corn and rice are due to adopted technologies developed by the collaboration NARS/IARCs.

(e) Yields

Despite subjective estimates of spread and possible impact of new technologies and the significant increases in rice and corn yields reported by the CNP in Tables 4 and 6,

the study by ISNAR (1981) using data from AID, BID, and IBRD shows zero increase in basic grain yields over the period 1962-1976. (See Tables 24 and 25).

Table 24. Costa Rica: Factors determining production increases in export crops and basic grains (percentages)

	Export Crops		Basic Grains	
	Production increases due to		Production increases due to	
Period	Yield increases	Increase in cultivated area	Yield increases	Increase in cultivated area
1962-66	70.7	29.3	0.0	100.0
1962-72	75.1	24.9	0.0	100.0
1972-76	0.0	100.0	0.0	100.0

Source: AID, BIF, IBRD, Informe Tripartito 1978 and Oficina de Planificacion Sectorial Agropecuaria (OPSA).

Table 25. Costa Rica: Factors determining production increases of some crops between 1962 and 1976 (percentage)

Crop	Production increases due to increases in yields	Production increases due to increases in acreage
Coffee	0.0	100.0
Banana	100.0	0.0
Sugar Cane	0.0	100.0
Cocoa	-61.5	-38.5
Rice	0.0	100.0
Corn	0.0	100.0
Beans	0.0	100.0
Sorghum	-	-
Cotton	0.0	100.0
Tobacco	36.7	63.3
Potato	50.7	49.3
Cassava	100.0	0.0
Plantains	100.0	0.0
Onions	0.0	100.0

Source: AID, BIF, IBRD, Informe Tripartita 1978 and Oficina de Planificación Sectorial Agropecuaria (OPSA).

4.4 Innovations with Potential Impact

There are very few innovations currently being tested that have potential for great impact on Costa Rica's agriculture. The MAG's rice program is about to release the variety CR-1821 developed in collaboration with CIAT, which they claim is resistant to Pyricularia and has the potential to yield 11.3 ton/Ha, at the farm level. It is also testing the variety CR-1549 developed from lines provided by CIAT and IRRI, whose yield potential is 9.3 tons/Ha at the farm level. Foundation seed of CR-1821 was being produced in 1985.

In 1984, the national beans program tested line D-145 from the ICTA-CIAT collaboration and included it in its certifying program under the name of Huasteco. Genetic seed was being produced in 1985. It adapts well to places infested with "telaraña" (cobweb) and is resistant to other diseases. National scientists think it has great potential for increasing beans yields in Costa Rica.

The national corn program will release in 1985-86 the following varieties.

Variety	Yield potential in tons/ha
Diamantes 8343	5.5
Las Cañas	5.0
EJN V-7	5.5
Tico V-6	5.0

The sorghum program plans to release in 1985-86 the following materials:

Variety	Yield potential tons/ha
ISIAP dorado	9.5
Litoral 5	10.8
V-816	10.0
G 522 DR	9.9
D-185	9.9

CHAPTER 5. CONCLUSIONS

Based on numerous interviews, field visits and review of the literature, the author has the following observations in summary of this investigation.

A. The NARS, its Research Methodology and its Limitations

A great deal of research, especially evaluation of lines and varieties, is still being done under conditions far removed from those of the farmers, despite the statement of the new Director of Research, who said that 40 percent of the reserch is done at the experimental station and 60 percent on farmers' farms. Beans materials, for instance, were being evaluated on flat land planted as a monoculture when next door the farmer is growing all his beans on steep slopes in combination with other crops.

It appears that the research is not directed at solving specific and relevant problems; many lines are evaluated every year, but very few, if any, reach the farmer.

The lack of inter-institutional coordination of the NARS as a system, and the financial problems of the MAG, are factors that tend to reduce the potential impact of collaboration between the IARCs and the NARS. There was at least one instance in which not enough seed of a corn variety resulting from such collaboration was available to farmers, who had accepted and were demanding the variety. This was due to the fact that the NARS simply did not produce the seed after it was accepted. Later, this same variety was allowed by the NARS to lose its purity and its good characteristics. With the return of a maize specialits (now head of the program) who was being trained at the graduate level by CIMMYT, it is expected that these problems will not recur.

The gulf that has always existed between research and extension in Costa Rica has been a great impediment to the impact of collaboration with IARCs at the farm level. Technology developed is seldom, if ever, validated at the farm level. In May, 1985 the Ministry of Agriculture was reorganized, bringing the divisions of research and extension together under a single division called Dirección de Investigación y Extensión Agrícola, with one director for both research and extension. This was done to bridge the traditional gap. My own impression, however, is that at the regional level things will continue to operate as always, unless some substantial changes in the modus operandi of the Centros Agrícolas Regionales are made; i.e., if the extension agents participate in the planning and execution of research.

The way the system has worked so far is well described by the following observation of the ISU team:

> "In Costa Rica, there is an annual meeting at which extension specialists from the regional centers and the national research staff meet to discuss their priorities for the coming year. Extension personnel at the national level feel that these meetings are designed to provide an opportunity for national research staff to 'tell' the others what the priorities will be for the year, rather than having a dialogue about it."

Although the centers have done an excellent job in training NARS personnel, there is need for more training. Some NARS scientists would like to see more theory incorporated in the training programs at the centers; they also believe that more in-country training is needed and could be more efficient, and stress the need for more training at the graduate level. It seems that the NARS has reached a point where scientists trained at the graduate level could greatly improve the communication with their counterparts at the IARCs and increase the potential for impact. One cannot ignore, however, the fact that the

necessary incentives (salary) to keep these people within the system are lacking at the present time. It has also been pointed out that the organization of the MAG and the salary structure are not conducive to attracting good professionals.

Because of the ever-present limitations of the official institutions, the author strongly believes that collaboration with the private sector offers great potential for impact. The Cámara Nacional de Granos Básicos, an organization of grain producers, offers a great opportunity for such collaboration. They are doing their own research and extension, and are eager to work with the IARCs.

B. Private Seed Producers

Given some of the problems of the NARS pointed out above, the greater the participation of private seed producers in the process the greater will be the potential for continued impact of the IARCs.

Private seed producers would like to have greater participation in the IARCs activities, such as courses and conferences. Some of this is already taking place, especially with CIAT, where private seed producers help give seminars, write handbooks, etc.

Private producers of varieties and hybrids would like to work with genetic material directly from the IARCs. Despite the political implications, this is an option that might be considered. At least the process of going through the NARS could be made easier.

Seed pricing in Costa Rica at all levels could become a deterrent to private producer's participation, thus setting back the system and reducing opportunities for impact.

Beans seed, for example, is subsidized by the CNP, preventing any participation of private producers.

C. Overall View of IARC's Contribution

Scientists in the NARS, in general, consider the collaboration of the IARCs to be essential and invaluable. Most of the activities of the IARCs were rated highly. Training and the provision of genetic material are considered essential for a viable national program. National scientists expect the important work of the centers not only to continue but to be expanded.

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APPENDIX

Prices of Basic Grains in Costa Rica

Table A.1. Rice: Domestic and world farm and retail prices (colones per quintal)

Year	Prices[1] P_{fd}	P_{fw}	P_{rd}	P_{rw}
1950	45	38.3	.	50.5
51	50	38.5	.	50.8
52	56	41.7	.	54.9
53	56	46.6	69.7	61.4
54	56	42.1	70.0	55.5
55	56	37.7	68.0	49.7
56	62	36.5	69.1	48.1
57	62	36.6	74.0	48.2
58	62	37.9	82.2	50.0
59	63	49.1	82.6	64.7
60	68	54.2	84.8	71.4
61	68	61.8	88.8	81.4
62	68	64.4	87.9	84.9
63	68	60.9	88.3	80.3
64	68	57.8	86.9	76.2
65	68	56.5	88.1	74.4
66	68	57.8	89.0	76.2
67	63	59.9	88.8	78.9
68	68	58.9	88.9	77.6
69	68	59.9	89.1	78.9
70	60	61.6	90.5	81.2
71	68	63.4	90.5	83.5
72	68	93.9	102.3	123.7
73	68	190.2	101.2	250.7
74	73	165.4	111.2	217.9
75	110	155.3	142.5	204.6
76	142	126.3	174.8	166.4
77	125	186.7	167.9	246.0
78	132	145.1	161.0	191.2
79	139	191.1	184.0	251.8
80	149	188.0	197.8	247.7

[1] P_{fd} = domestic farm price
P_{fw} = world farm price
P_{rd} = domestic retail price
P_{rw} = world retail price

Source: Stewart, 1984.

Table A.2. Beans: Domestic and world farm retail prices (colones per quintal)

Year	Prices[1] P_{fd}	P_{fw}	P_{rd}	P_{rw}
1950	.	80.9	.	94.7
51	41	79.4	.	92.9
52	44	72.2	.	84.5
53	46	61.1	54.6	71.5
54	45	77.1	55.1	90.3
55	45	81.2	55.3	95.1
56	45	52.5	65.8	61.4
57	45	53.2	62.8	62.2
58	45	52.0	66.1	60.9
59	46	94.5	67.5	110.6
60	50	55.4	71.1	64.9
61	50	59.9	87.1	70.2
62	55	64.8	77.3	75.9
63	55	88.3	69.9	103.4
64	55	76.6	78.9	89.7
65	55	87.1	74.1	101.9
66	55	67.7	71.8	79.3
67	45	98.1	81.5	114.8
68	60	166.3	87.2	194.6
69	65	80.4	79.7	94.1
70	56	140.4	109.0	164.3
71	75	101.3	102.0	118.5
72	75	201.5	101.2	235.8
73	75	299.1	100.0	350.0
74	85	239.8	219.0	280.6
75	225	219.9	263.0	257.4
76	225	197.2	264.5	230.7
77	225	350.2	264.5	409.9
78	225	211.5	264.5	247.5
79	225	288.4	300.1	337.5
80	285	318.3	335.8	372.5

[1] P_{fd} = domestic farm price
P_{fw} = world farm price
P_{rd} = domestic retail price
P_{rw} = world retail price

Source: Stewart, 1984.

Table A.3. Corn: Domestic and world farm and retail prices (colones per quintal)

Year	Prices[1] P_{fd}	Pfw	P_{rd}	P_{rw}
1950	.	20.9	.	25.5
51	20.0	21.0	.	25.6
52	21.0	18.3	.	22.3
53	26.0	17.5	27.8	21.4
54	22.5	17.0	28.3	20.7
55	22.5	14.2	29.4	17.4
56	24.0	15.0	29.7	18.3
57	24.0	13.9	29.9	16.9
58	24.0	13.9	29.4	16.9
59	24.0	13.4	29.4	16.4
60	23.0	14.1	29.2	17.2
61	23.0	14.9	29.8	18.2
62	23.0	17.6	29.3	21.5
63	23.0	18.8	30.8	22.9
64	23.0	19.2	30.2	23.4
65	23.0	18.9	30.0	23.1
66	25.0	20.4	30.1	24.9
67	25.0	17.1	30.6	20.9
68	25.0	16.8	31.1	20.5
69	26.0	18.5	31.0	22.6
70	23.5	20.1	34.4	24.5
71	30.0	20.1	44.1	24.5
72	30.0	19.2	42.3	23.5
73	32.0	33.8	43.4	41.2
74	38.0	54.5	58.1	66.4
75	75.0	53.1	83.9	64.8
76	75.0	49.9	89.9	60.9
77	75.0	42.3	92.0	51.6
78	75.0	44.7	96.6	54.6
79	82.0	51.3	101.2	62.6
80	.	55.7	115.0	67.9

[1] P_{fd} = domestic farm price
P_{fw} = world farm price
P_{rd} = domestic retail price
P_{rw} = world retail price

Source: Stewart, 1984.

Table A.4. Nominal rate of protection at the farm level

Year	Rice	Beans	Corn
1950	0.17325	.	.
51	0.29676	-0.48400	-0.04946
52	0.34195	-0.39075	0.14727
53	0.20059	-0.24725	0.47755
54	0.32793	-0.41684	0.32115
55	0.48202	-0.44639	0.57665
56	0.69619	-0.14339	0.59227
57	0.69211	-0.15437	0.72451
58	0.63224	-0.13537	0.72451
59	0.28165	-0.51330	0.78189
60	0.25407	-0.09867	0.62539
61	0.10025	-0.16655	0.53398
62	0.05521	-0.15212	0.30001
63	0.11491	-0.37778	0.22140
64	0.17487	-0.28254	0.19669
65	0.20346	-0.36856	0.21424
66	0.17487	-0.18872	0.22299
67	0.05081	-0.54137	0.45650
68	0.15418	-0.63936	0.48046
69	0.13420	-0.19200	0.40138
70	-0.02743	-0.60116	0.16866
71	0.07248	-0.25986	0.49191
72	-0.27593	-0.62788	0.55640
73	-0.64262	-0.74928	-0.05344
74	-0.55873	-0.64554	-0.30282
75	-0.29175	0.02287	0.41069
76	0.12406	0.14088	0.50083
77	-0.33063	-0.35769	0.77024
78	-0.09045	0.06355	0.67520
79	-0.27276	-0.21987	0.59621
80	-0.20752	-0.10477	

$$NPR_i = \frac{P_{fd} - P_{fw}}{P_{fw}}.$$

Source: Stewart, 1984.

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